Assignment 3

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1 Questions

Discuss feature extraction power of your favorite CNN pretrained by ImageNet datset before and after transfer learning by MNIST didgit dataset by plotting high dimensional feature vectors on 2D plane using three dimension reduction techniques.

2 Solution

Solution Github link

Initially, we used a CNN model named ResNet18, which was trained on the ImageNet dataset, not on the MNIST digits dataset. We worked with 500 MNIST digit images and used PyTorch to do all our processing and training. We collected the feature vectors from the model and used three methods—PCA, t-SNE, and Isomap—to show the results in 2D graphs.

Before transfer learning, the ResNet18 model did not understand digit images well. On the 2D graphs, the feature points for different digits were all mixed together. There were no clear groups for each digit. This happened because the model's features were made for normal pictures, not for handwritten numbers. So, the model could not separate one digit from another.

After transfer learning, we trained the ResNet18 model with the MNIST digit images. Now, when we look at the 2D plots, the points for each digit are grouped much better. Especially in the t-SNE plot, every digit makes its clear group, and different groups are far from each other. PCA and Isomap also show better separation between digits after training. This means the model learned new features that help it tell the digits apart.

In conclusion, transfer learning helped the model change from only understanding normal images to also understanding handwritten digits. After training, the feature vectors made by the model are much more useful. The model can now group each digit.

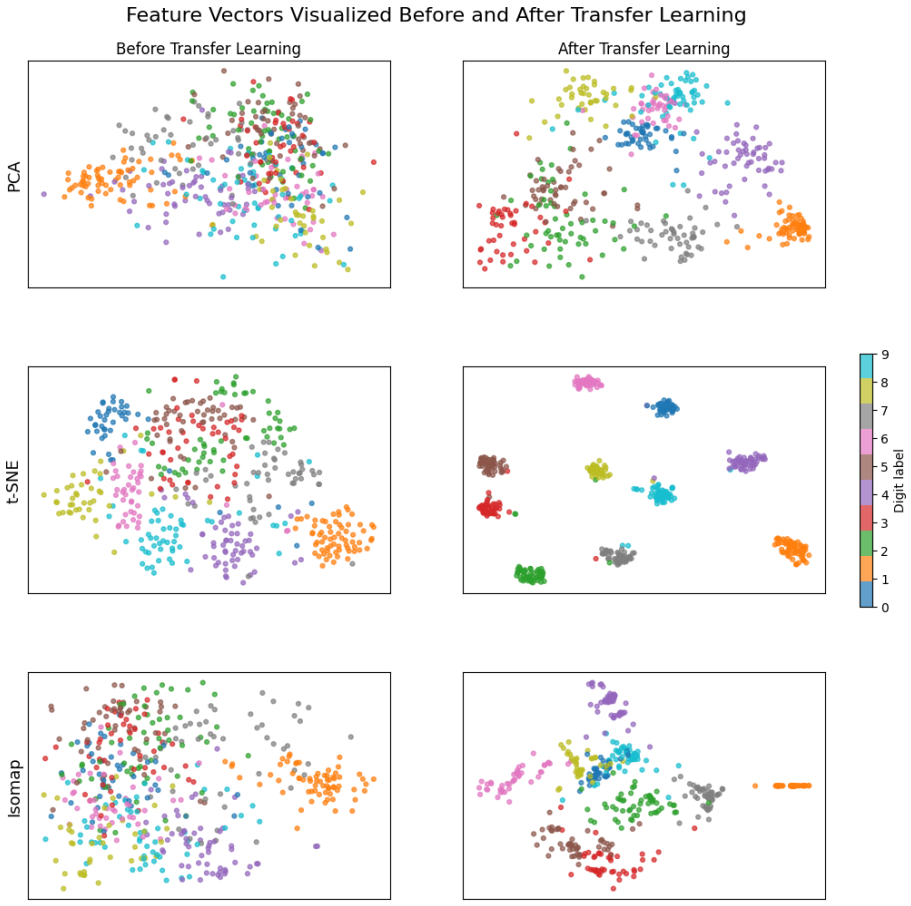

Figure 1: This picture shows how high-dimensional feature vectors in 2D. Before training, the numbers are mixed. After training, the model groups each digit clearly.